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The Many Faces of Design
From Adaptive Response to Creative Agency to Emergent Engagement

Abstract
In light of contemporary global pressures, designers have been considering how to apply their thinking and practice more broadly within the enterprise of sustainability. Given the often wicked nature and cross-scale dynamics of related challenges, there is reason to reassess the role of design in processes of systems transformation amidst complexity. In this manuscript, the author contemplates the diversity of 'designerly ways', in interpretation of designers' encounters with complex adaptive systems. These interactions are classified here using the three lenses of adaptive response, creative agency and emergent engagement.

Keywords: sustainability, resilience, complex adaptive systems, emergence, designerly ways, transition design, social innovation

Introduction

Design is pervasive as both act and outcome, which makes it difficult to establish clear boundaries for its practice, especially recently, as the application of design expertise is being extended beyond classic design problem contexts. For example, within the last half century, in light of scientific concern regarding depleting natural resources, anthropogenic impact on earth systems, the increasing pace of global change, and interconnected systems risks (see Crutzen, 2006; Homer-Dixon, Walker, Biggs, Crépin, Folke, Lambin, Peterson, Rockström, Scheffer, Steffen & Troell, 2015; Meadows, Randers, & Meadows, 2004; Steffen, Broadgate, Deutsch, Gaffney, & Ludwig, 2015; Young, Berkhout, Gallopin, Janssen, Ostrom, E., & van der Leeuw 2006), we designers have also been stirred to consider our role in sustainability transition (see Fuller, 1981; Irwin, 2015; Margolin, 2002; Mau, 2010; Papanek, 1971; Tonkinwise, 2015).

It would be difficult to imagine transition without design; discussions about alternative futures inevitably evoke a design mindset, regardless of whether we refer to it as such. However, identifying appropriate roles for designers within transition processes is not as straightforward as it may seem. For example, somewhere between sustainable design and design for sustainability, contemporary designers' intentions become ambiguous. This distinction may appear trivial and murky, although it is key to understanding the position of designers within complex and emergent systems dynamics. Sustainable design implies a conscientious approach that embraces clear values, principles, best practices and process-focused analyses; this could be applied to any regular design activity, like architecture or product development (see Dusch, Crilly, & Moultrie, n.d.). For interdisciplinary designer, Bruce Mau (2010), sustainable design extends miles beyond design as style and form, in its consideration of material and energy flows, user engagement and other context-based factors. According to Mau (2010, p. 24), "Sustainable design is a networked ecology", meaning that it is systems oriented. However, even a systems-based approach does not quite encapsulate the nascent face of design for (or with) sustainability. In addition to reforming conventional practices to align with sustainability mandates, contemporary designers are also looking to engage deeply with the complex issues that characterise sustainability dilemmas. *Naturally, this leads to questions about how to design for and with emergence.*

Flipping between these two positions—sustainable design and design for sustainability—is entirely intuitive, which is why it can be easy to overlook the difference. For

example, when sourcing materials for a building project and searching for sustainably harvested options, the *system* of material production, extraction and distribution suddenly enters our peripheral view. It is part of the networked ecology of sustainable design. Thus, in attempting to tune the strings of sustainability through a specified project, the systemic barriers to doing so might reveal themselves as prospective foci for future "design intervention". While many designers will be committed to channelling sustainability efforts through their designated professional practices, those who operate in more transdisciplinary domains have the freedom to jump between broad and specific concerns. The distinction is one of orientation: We can manage our relationships with the networks that stretch out from pre-determined design projects, using principles of sustainability, or we can propose design-like interventions based on analyses of the systems in which we are situated, more generally. Sustainable design can nest within design for sustainability; however, we should not assume that the cumulative effects of sustainable design projects will inevitably engender comprehensively sustainable systems. The difference becomes most apparent in instances where we have diverted so considerably from the path of sustainability that conventional design retrofits would be insufficient, on their own, as a strategy for change. At this stage, it would be worth evaluating how we can refine "designerly ways" (see Cross, 2007; Nelson & Stolterman, 2012) to integrate with other disciplines and respond effectively to some of the complex concerns that we are welcoming into design studios.

In 1973, Rittel and Webber introduced the concept of *wicked problems*[i] to acknowledge the existence of and offer approaches to dealing with the ill-defined issues that were appearing in planning contexts. The term has since been widely adopted by design communities and others, especially with reference to sustainability challenges (Brown, 2010; Curran, 2009). Rittel and Webber (1973) conceded that professional disciplines of the time were not well equipped to work with "open social systems", and that interconnections within networks of systems could obscure understanding of how and where to intervene. Forty years later, their 10-point list describing these challenges is still timely. However, they have underrepresented a very basic, yet critical, piece of the story: Sustainability dilemmas are so much more than wicked—at least in terms of Rittel and Webber's conception of wickedness, which denotes something malignant, vicious, tricky or aggressive. Oftentimes, sustainability issues are also complex. Although Rittel and Webber's writing is evocative of complexity thinking, they do not explicitly discuss how to engage with the behaviours of *complex adaptive systems*[ii] within planning practices. As designers, we could use further articulation of the implications of surprising, non-linear, self-organising and emergent systems phenomena on our various lines of work.

As settings for potential design interventions, wicked or complex adaptive systems are moving targets (see Brown, 2010; Holland, 1992), the state of which may be subject to change during the course of problem solving. Facilitating responsible agency within complex adaptive systems requires recognition that we are only co-creative agents. We designers cannot control all factors present within the contexts in which we work; numerous phenomena intersect with the human-constructed world, which occur through mechanisms quite separate from human agency. If our designed creations have fallen off the sustainability track, it may be just for this reason: We have dashed forward enthusiastically, charmed by our generative capacities, without giving due credence to the socio-ecological settings in which we are embedded. Human creativity needs both nurturing and grounding. We rely on human ingenuity to lead the charge towards novel futures (Westley & McGowan, 2014; Westley et al., 2011); we also depend on rigorous scientific analyses to ensure our propositions are safe and suitable for communities and ecosystems.

Brown (2009) has noted that designers' interest in complex social issues is not new. As he has suggested, managing complex societies is a creatively compelling challenge; historically,

the greatest design thinkers have always "searched out the problems that allowed them to work at the edge because this was where they were most likely to achieve something that has not been done before" (Brown, 2009, p. 203). At the same time, the complex social systems that we are embedded in today, and their impact on earth systems, are qualitatively and quantitatively distinct from early 20th century conditions; so too are the stakes that oblige systems change more significant (see Homer-Dixon et al., 2015; Steffen et al., 2015a; Steffen et al., 2015b). Sustainability transition is a playground for those looking to cut their teeth on knotty dilemmas. To engage in these complex issues, some design practitioners and institutions are intentionally facilitating or placing themselves within cross-sectoral change processes (see Brown, 2009; ideo.com; institutewithoutboundaries.com; slab.ocadu.ca; Westley & McGowan, 2014), seeking to endow their work with relevance at the scale of systems transformation. This may raze the popular understanding of what designers do or what kinds of questions are applicable for exploration through design-based problem solving.

Design for sustainability is arguably a different kind of design because it implies a greater scale of impact, a higher degree of complexity, increased transdisciplinarity, and work within dispersed, multi-actor networks. Transition design cannot be contained within design studios, alone. As design expands its range of interest, it will necessarily interface with other areas of analyses and action, in processes of "open critical inquiry" (Brown, 2010). As we cross between sustainable design and design for sustainability, we might consider recalibrating our methodologies. This manuscript explores designers' relationships with the systems in which we are acting, and the nature of the agency we exhibit in doing so, with the aim of shedding light on the role of design in systems transformation amidst complexity. The following interpretation of design bestows it with a pragmatic flexibility, wherein design-based inquiry can maintain interpretive and analytical merit separately from its application in specified designed outcomes.

Adaptive Response[iii]

> Design is a natural and ancient human ability—the first tradition among many traditions of human inquiry and action. (Nelson & Stolterman, 2012, p. 1)

Some descriptions of designerly ways intimate that design-like conduct is innate in human behaviour (Berger, 2009; Cross, 2007; Nelson & Stolterman, 2012; Van der Ryn & Cowan, 1996). In this premise, there is a general inference that everyone is a designer, and perhaps by extension, that design professionals have merely refined commonplace approaches to problem solving. At first glance, this view may seem to both minimise the role of designers and overextend our interpretation of design-like acts. However, the benefit of such an open definition is that it casts design practice in the light of adaptive resilience. If we construe human creative ingenuity as an adaptive capacity[iv] (see Lappé, 2011), then design naturally falls under this general umbrella, along with other feats of making, invention and innovation: "As human beings, we continuously create things that help reshape the reality and essence of the world as we know it" (Nelson & Stolterman, 2012, p. 1). From this description, we could further extrapolate that design as an adaptive capacity represents an informal, intuitive ability to modify the conditions of our own existence, perhaps with the intention of improving them in some way, perhaps by necessity or out of curiosity.

At the risk of forcing overly simplified assumptions about the countenance of early homo sapiens, it is useful to ponder whether designerly ways hold an epistemological and ontological significance that transcends historical and geographical contexts. For example, it would not be unreasonable to classify the symbolic representation of reality, the projection of future realities, the repurposing of found objects, or tacit engagement with the material world through craft and building as design-related mechanisms by which early human populations

adapted their lived experiences. Designerly ways are sometimes framed as ways of knowing, means of inquiry or methods of sensemaking, which are distinct from and integrative of other scientific, logical, artistic, intuitive and spiritual traditions (Buchanan, 1992; Kolko, 2011; Nelson & Stolterman, 2012). As much as design is a practice, it is also a mindset and a way of being through which we come to know and act within the world around us (see Nelson & Stolterman, 2012). The irony of this open framing is that we end up granting historically neutral relevance to a practice that is predominantly context dependent and customised in its execution. Here, my interest is to identify commonalities, which may exist across contexts, in the types of design-like behaviours occuring, more so than the resulting 'designs'.

To begin, we could propose that design as an adaptive response implies an immediate, direct, local, incremental and self-organised approach to decision making and action within inhabited environments—a kind of systems shuffling at a micro level, through self-correcting patterns of use, which may or may not lead to transformative effects. For example, we see this notion appearing in the writings of Alexander (1964), Van der Ryn and Cowan (1996), Ingold (2000) and Berger (2009). By their accounts, design as an adaptive response emerges naturally within the course of everyday routines; professional creative training is not a requirement, nor are there external design authorities analysing and advising on project outcomes. Presumably, these kinds of self-organizing behaviours would be universal, regardless of time or place, although the focus, effects and outcomes might differ depending on the structure and scale of the systems in which they transpire.

Most of the authors listed above describe design as an adaptive response with reference to small scale, pre-industrial communities. Van der Ryn and Cowan (1996) have explained that "For most of our tenure as a species, design has been … embedded in culture, learned through daily participation in the life of the family and community" (p. 169). This particular breed of design, or what Alexander (1964) has also termed as "unselfconscious processes",[v] is guided by tradition, local knowledge, replication of trusted templates, experiential trial and error, close engagement with the environment and expression of cultural ways of being (Van der Ryn & Cowan, 1996). A similar position is introduced in Ingold's (2000) "dwelling perspective", wherein building is portrayed as a function of living: "the forms people build, whether in the imagination or on the ground, arise within the current of their involved activity, in the specific relational contexts of their practical engagement with their surroundings" (p. 186). For Ingold, design-like acts need not result in physical construction; rather, the deliberated "co-option" of existing objects for specified purposes is suitably designerly. According to Alexander (1964), in these unselfconscious cultures, consistency and continuity is preferred, while change is resisted. Communities maintain equilibrium within systems by adjusting them in response to disturbances and perceived failures—nothing more.

In contemporary, industrialised societies, we could argue that design as an adaptive response still appears as a general behaviour, although the conditions in which it takes place differ considerably. In these settings, professional design agents have arrived on the scene—in many cases, displacing local knowledge (Van der Ryn & Cowan, 1996)—and communities' relationships with their inhabited environments are mediated through dense layers of infrastructure and bureaucracy. Effectively, we are adapting within a tighter web of socio-ecological constructions. As such, the capacity of citizens to modify systems to significant effect, within the "current of their involved activity", may be limited, indirect, or untargeted; complexity renders industrialised systems less accessible to immediate change by the masses. This does not rule out the importance of localised, community efforts, altogether; however, it may be more onerous for individuals and communities to self-organize within systems over which they have minimal ownership or authority. Van der Ryn and Cowan, as well as Berger, offer interpretations that transfer the unselfconscious processes of dwelling, most naturally associated with traditional cultures, into contemporary settings. For these authors, individuals

exercising choice within basic life scenarios could be classified as acts of design:

> We constantly make decisions that shape our own futures and those of others. We choose our everyday reality: where and how we live, how we use our time and energy, what we value and whom we care about, how we earn and spend. All these choices involve dimensions of design.
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> (Van der Ryn & Cowan, 1996, p. 169)

Adaptive design-like behaviours may transcend factors of time and place, however, the overall effects of these actions could vary depending on the relationship of agents to the systems in which they are embedded. Where Alexander (1964) has characterised adaptive processes in unselfconscious cultures as a regulation mechanism, ostensibly enhancing resilience, Berger (2009) has noted that the cumulative outcomes of individual adaptations in contemporary settings are not always desirable. For example, he has explained how something as simple as individual home-buying decisions can shape urban settings, and instigate issues such as sprawl and car dependence. Additionally, he has contended that agents responding spontaneously to their immediate circumstances may be blind to broader systems dynamics: "Everyday design decisions and actions often tend to be reactive … addressing individual challenges as they rise to the surface instead of anticipating them and dealing with them as part of a cohesive systems-design approach" (Berger, 2009, p. 242). Thus, design as an adaptive response may not automatically produce well-adapted solutions, especially when the systems with which we are working are too unwieldly to comprehend comprehensively. Alexander (1964) has spoken to this by acknowledging that complexity and the current pace of change cripple the ability, not only of citizens, but also of design agents to work adaptively: "No sooner is adjustment of one kind begun than the culture takes a further turn and forces the adjustment in a new direction" (p. 56). In other words, there is less opportunity to fine-tune the "fit" of newly designed components to rapidly shifting systems; we can no longer keep up with the cumulative dynamics of cultural change.

If we attempt to explain the unfitness of contemporary designs with respect to their environments, the variance between processes of natural evolution and cultural change becomes a point of curiosity; not to mention, one that is awkward to account for without postulating an arbitrary division between human cultural and ecological systems. Looking to the thinking of Alexander, Van der Ryn and Cowan, and Ingold, it is easier to imagine a variety of design-based actions and outcomes that could emerge organically through our relationship with the biosphere. This is foundational in Ingold's dwelling perspective, after all: "…if, by cultural variation, we mean those differences of embodied knowledge that stem from the diversity of local developmental contexts, then far from being superimposed upon a substrate of evolved human universals, such variation must be part and parcel of the variation of all living things, which has its source in their enmeshment within an all-encompassing field of relations" (p.187). There may be something to say, however, about an overall design learning curve, in which we (the human community) are seemingly close to reach a new peak. At least, this is inferred in biomimicry thinking (Benyus, 1997), which criticises the relative crudeness of human creations, compared with works of Mother Nature, while taking steps to translate the wisdom of the natural world into design practice. The question remains: Why are we (the human species) so maladapted, and could further examination of design-like conduct lend insight to the issue?

It is inevitable to position behaviours that exemplify designerly ways as part of our strange evolutionary advantage (see Gopnik, as cited in Lappé, 2011). The human species possesses the ability to share knowledge across generations and combine ideas to form new ideas, all of which can accelerate the pace of cultural change (Arthur, 2009; Christian, 2004; Gould, 1996). Lovelock (2014, p. 55) has claimed that "We have evolved to become inventors." As our designerly skills have expanded, so too have we adapted the means by which we adapt; we adapt on the back of our own creations. For example, the refinement of sophisticated

languages has been identified as a creation that modified how we create (Diamond, 1995; Van Alstyne & Logan, 2007): "Without language, we cannot communicate a complex plan, nor think out the complex plan in the first place, nor brainstorm about how to design a better tool, nor discuss a beautiful painting" (Diamond, 1995, p. 49). Language liberates imagination, and imagination fuels change. Language in this sense also refers to forms of visual communication. If we consider something like sketching to be an intuitive, adaptive advancement, then the meta-level significance of designerly ways as an adaptive mechanism is clear. To Alexander's (1964) point, we could ask whether we have adapted too quickly and at too great a scale to integrate sufficient learning along the way. We could also argue that confidence follows learning. By virtue of the knowledge acquired through tacit engagement with our surroundings, we may eventually gain the self-assurance to reconstruct these on our own parameters, asserting our creative voice. With this, we enter the space of design as creative agency.

Creative Agency

> "More than any other creature, human beings are able to change … in light of experience" (A. Gopnik) … We can learn about our environment, we can imagine different environments, and we can turn those imagined environments into reality. (Lappé, 2011, p. 100–101)

Creative agency is an obvious proclivity of contemporary designers, who exude a certain confidence in giving shape to the world in which we live; though, we can sometimes be quite loose about what 'giving shape' entails. For example, when design is described as "the capacity to plan and produce desired outcomes" (Berger, 2009, p. 241–242) or "the intentional shaping of matter, energy, and process to meet a perceived need or desire" (Van der Ryn & Cowan, 1996, p. 24), the boundaries for the field are blown open. Van Alstyne and Logan's (2007) definition reigns this in a bit, as it designates design as "a 'problem-solving' activity, the objective of which is the reproduction of a product, service, or other form of organization" (p. 121). Still, the last qualifying category of "other form of organization" leaves room for interpretation regarding exactly what we will be transforming and to what ends. This is a good thing because it compels us to notice intentionally coordinated order within the human-constructed world even when it is intangible. With design practiners embarking on less delineated areas of work, a new concept has appeared, the definition of which is equally fuzzy. "Design with a capital D" (see Kolko, 2007), as a term, leads us to consider how designers can apply creative agency beyond the development of "things" to tackle wider concerns related to the ordering of systems. A similar conception is included in Fuller's thinking, where he "defines design as the deliberate ordering of components … distinguished from randomness" (Edmonson, 2007, p. 287). On these terms, we as capital D designers are creative agents of systemic order; so too should we be its interpreters.

Just as the term 'design' can be applied as a verb or a noun, an act or an outcome, so should the concept of "capital D design" be interpreted as both. Capital D design can refer to an approach to practice; it could also signify the ordering or organisation already present within the human-constructed world. This second interpretation is not common, though it appears implicitly in Mau's thinking, as he deliberates the role of design in influencing positive change (see Berger, 2009; Mau, 2010; Mau, Leonard, & the Institute without Boundaries, 2004). Arguably, if we do not refine our discernment of intentionally organised order, it would be difficult to become effective capital D practitioners. From the perspective of systems-oriented design, the point is obvious: Any exercise in the reorganisation of a given system would begin, presumably, with observations of its current state. Part of the challenge for our capital D sensibilities is to cultivate awareness of the micro- and macro-level ordering of systems as a preamble to their restructuring. For example, Mau et al. (2004) have pointed out that designed

systems can become so commonplace that they fade into the backdrop of the everyday: "Most of the time, we live our lives within these invisible systems, blissfully unaware of the artificial life, the intensely designed infrastructures that support them" (p. 5). On the one hand, as they (Mau et al., 2004) have identified, we would want our physical surroundings to fit so naturally with our daily routines that we become oblivious to their details. After all, why struggle through a process of re-learning how to switch on a light each time we enter a room? On the other, these small, overlooked details may contain clues to aid system transformation. In design for sustainability, it is important to dislodge our normalisation of the familiar, while critically assessing the logic and merit of the bubbles that sustain us. Cross (2007) has also discussed the persuasive or rhetorical aspect of design, whereby each design offers a proposition of how to "be" in a given context. In other words, designs can condition behaviour. As creative agents, we have a responsibility to decode how our constructed realities impart meaning in this way: "Tomatoes, flush toilets, cars, nuclear-power plants, culverts, and suburbs each embody an epistemology in which environmental concerns may or may not play an explicit role" (Van der Ryn & Cowan, 1996, p. 24). Interpreting the existing order of a system, including the underlying worldviews, may not always precede intervention, though we should keep this within the repertoire of design inclinations and services—"we can learn about our environment" (Lappé, 2011, p. 101). From here, we can imagine our future within it.

Imagination is another facet of creative practice that can occur without any intention to act or intervene within a system. It is part of designers' interpretive role. For example, envisioning prospective futures can be a productive means of translating our collective values and desires into tangible design schemes. Examining the nuances of *what is*, *what could be* and *what should be* is a beneficial exercise in its own right (Brown, 2010); along similar lines, so too is navigating the "adjacent possible" [vi] (Johnson, 2010; Kauffman, 2000; Simon, 1996), the 'design space' [vii] or multiple variations on conceptual themes. These are all legitimate acts of creative agency, which we should avoid supressing in our impatience for change. Though the outcomes may be conceptual rather than action oriented, an 'intervention' still takes place within the realm of social perception. We should not dismiss collaborative visualisation activities as fanciful or unproductive; the exploration of design alternatives is a worthy expression of creative agency – "we can imagine different environments" (Lappé, 2011, p. 101). There does come a critical turning point for creative agents, however, when we finally decide to realise our ephemeral notions as something that is more or less concrete—"we can turn those imagined environments into reality" (Lappé, 2011, p. 101). For us designers, the prospect of doing so will usually be in the back of our minds throughout the brainstorming and visualisation phases, which naturally influences what and how we imagine. Any designer could indulge in surreal daydreams of far-off utopias without difficulty, but more often, we tend to substantiate systems-oriented practices in a pragmatic assessment of existing constraints and opportunities (see Brown, 2010). This is the greater challenge. Creative agents must possess the conceptual proficiency to visualise future states, as well as the technical aptitude to work within the parameters of existing socio-eco-technological contexts. Creative processes for sustainability transition could be initiated within the world of fantasy, though ultimately have the chore of finding their way to the ground.

Designers' application of imagination opens the door to an epistemologically and ontologically flexible approach to problem solving:

> According to [Roger] Martin, top designers have certain common characteristics, one being their rock-solid belief that reality is subject to change. When designers are confronted with a challenge that has no real-world answer … instead of saying, "Well, that's life," they are inclined to say, "No, there has to be a better answer out there if I think a little bit harder."
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> (Berger, 2009, p. 47)

Problem solving through design is driven by our enthusiasm to engage with unknown frontiers and entertain ideas that may not yet be resolved. Overcoming real, everyday challenges can prompt this innovation. Exploring the design space and evaluating the feasibility, viability, applicability and desirability (see IDEO, 2015) of options is a central facility of the design mindset: "The designer lets a lot of different models float around in the mind at the same time … [selecting] parts and pieces from those existing models to create new and better models" (Martin, as cited in Berger, 2009, p. 48). This process is both imaginative and organic as well as precise and analytical. It is organic in that it is iterative and the combination of alternatives may lead to unexpected results (see Arthur, 2009; Johnson, 2010); it is precise in that it is tied to a multitude of specific decisions related to the structure, function, composition, materiality and contextual significance of the design that is being produced. The process may also involve an assessment of alternatives with respect to project objectives, parameters, constraints and possible trade-offs. Berger (2009) has described the design intellect as one that can simultaneously hold conflicting ideas; accept ambiguity; and not oversimplify problems, choices or mental representations. The world in the mind of a designer is malleable—or, at least, designers find ways to make room for systemic reordering.

Of late, designers' enthusiasm for systems reordering has earnestly ignited to address the sustainability dilemma (see ideo.com; institutewithoutboundaries.ca; slab.ocadu.ca). The ontological flexibility granted by the design mindset motivates a continued search for novel means of surviving and thriving sustainably, and designers' comfort with systemic deconstruction and reconfiguration certainly helps. As stated earlier, sustainability principles can be applied in the creation of "small d" designs (e.g. products or buildings); at the same time, designers' capital D inclinations are inspiring us to think bigger—for example, planning for the welfare of all life through variant schemes of social organization (see Dusch et al., n.d.; Mau, 2010; Tonkinwise, 2015). The *Massive Change* project (Mau et al., 2004) was a turn of the millennium, multi-platform, travelling initiative that kindled this spirit. When commissioned by the Vancouver Art Gallery in 2002 to examine the future of design culture, Mau inverted the brief with the statement "Massive Change is not about the world of design; it's about the design of the world" (Mau et al., 2004, p. 11). Generally speaking, his project unpacks the ideas that human actions generate order within constructed systems, that many people co-create the world in which we live (whether intentionally or unintentionally) and that countless individuals and organisations are already committed to influencing positive change through ingenuity. Mau et al. (2004) categorised the systemic ordering of this ingenuity as 11 *design economies*, ranging from military to market to biological pursuits.

The semantic ambiguity of Mau's above statement has raised some eyebrows. General discussions have revealed reservations about the premise that design *can do anything* or that the world can be *designed* (see Mau, 2010). Indeed, the question "Now that we can do anything, what will we do?" (Mau et al., 2004, p. 15) evokes a creative optimism that may read as overly zealous. Similarly, the concept of capital D design could easily be mistaken for the coveting of an authoritative stronghold on whole systems. However, for Mau, the sentiment expressed is less about control than about responsibility: "As far as we're concerned, designers don't have the luxury of inaction or cynicism … [we] have to develop solutions" (Mau, 2010, p. 14). This is key. The penchant of the creative agent is to work generatively rather than reactively or in simple counteraction to current norms. The generative nature of design stimulates development of novel solutions. With respect to sustainability planning, this differs from strategies that focus on reducing that which is undesirable or propagating familiar preferences: "The purpose of generative interpretation is to experiment with different interpretations of reality, in order to create possible futures that are in line with our intentions…" (Nelson & Stolterman, 2012, p.124). Though the creation of novelty is a considerable benefit of design-based approaches to change, it can also bring about subsequent challenges. Without clarifying and regulating the

grounds upon which we are implementing socio-eco-technological innovation, we could quickly fall off the path of sustainability. At the scale of global or even municipal systems change, the challenges confronted are beyond the expertise of designers alone. Neither would designers hold sufficient knowledge of diverse life ways to propose new, comprehensive models. As creative agents, we do have some facility to shape the systems we inhabit, however must also humble ourselves to their currents and take note of how they react to our actions. With this, we enter the space of design as emergent engagement.

Emergent[viii] Engagement

> The question of control versus influence is the crux of the contrast between design and emergence. (Van Alstyne & Logan, 2007, p. 128)

Enabling transformative change in complex adaptive systems is an ambiguous pursuit, conducive neither to precise prediction nor to absolute control (Helbing, 2013; Van der Ryn & Cowan, 1996). Yet given the risks posed by the interdependent dynamics of global social, ecological, economic and political systems (see Helbing, 2013; Homer-Dixon et al., 2015), inaction is not an option. Such is the twist of the sustainability dilemma: Complex adaptive socio-ecological systems have manifested wicked issues, along with an urgency to respond to them, while simultaneously muddying our understanding of effective solutions. Alexander (1964) has noted that contemporary systems place escalating demands on designers, with designers being expected to assimilate increasingly more information into decision making. Yet no one designer or team of experts could possibly analyse all factors relevant to systems transformation for sustainability, comprehensively. Despite designers' best efforts to be transdisciplinary and systemic in our practices, we have yet to resolve how to best engage with the fluctuating, emergent, self-organising and surprising aspects of complexity. In this light, Tonkinwise (2010, p. 27) has asked, "Is taking account of a greater quantity of consequences something that can only be attained by a qualitatively distinct way of designing?" If so, then this new kind of design should certainly consider how we might exercise responsible agency while acting within dynamic systems over which we have limited control.

To begin, without being overly technical about the nature of surprise, we can suggest that there are certain types that are easier to account for in planning processes: Namely, the "known unknowns" [ix]. One obvious known unknown is that the space of innovation will be subject to ongoing change, through continued learning. Of course, designers are suitably prepared to cope with this kind of surprise. The emergence of novelty through experimentation and development sits well within our circle of comfort; in fact, enabling change through creative processes is what the newer faces of the design field thrive on. To some extent, we are relying on the surprising results of human ingenuity to open doors to alternative eco-socio-technological arrangements (Westley et al., 2011; Westley & McGowan, 2014). The prospect of ingenuity also reminds us not to over plan, as it is quite common for new inventions to overwrite the old. Besides, even if we could conceive of and create renewed civilisations in their totality, this is not an ideal approach. Tonkinwise (2010) has critiqued modernist design for its overly rationalist attempt to do just this: "Postmodernism in design was a reaction against the definitively modernist insistence that designers effect a complete transformation in the world, rupturing all extant modes of material and ideological being every time they design a new building, garment, or communication" (p. 28). From Tonkinwise's perspective, if we attempt to envision and implement an all-inclusive package for contemporary sustainability, we would only be resurrecting our former modernist inclinations. In addition to the known unknowns, there are also the "unknown unknowns" [ix], as well as dynamic ecosystems and climate factors that interact with the human-constructed world. For the purposes of

sustainability, managing the stuff of our own making is insufficient in itself. Rather, we are managing them *within* broader complex systems, which operate independently of human programming.

Just as designers have conceded to release the rationalist tendencies of modernism, we have simultaneously fallen into the hex of mutable boundary definitions that accompanies systems thinking (see Midgley, 2000, 2003). Capital D design is fundamentally systemic, and sustainability challenges are often wicked (Curran, 2009); so, when we combine a capital D approach with sustainability interests we might be left questioning where, precisely, the design-suited problem space begins and ends. To illuminate designers' position within indefinite problem contexts, how sustainable design can quickly flip into design for sustainability, or why the latter can be entirely vague in its objectives, it helps to consider Alexander's (1964) description of the blurry line that exists, in design decision making, between developing forms and interpreting contexts. He has opened this discussion with the claim that designers have an influence over the former, but not the latter, which seems simple enough; ostensibly, we design forms to be situated within contexts. However, as he has then proceeded to illustrate, delineating either form or context within a design project will be subject to boundary choices. Thus, an interpretive process of prioritisation enters the work of designers, whether intentionally or inadvertently, whereby we establish areas of focus for future interventions (see also Simon, 1996, on determining limiting resources). For example, priorities for intervention may depend on what we want a particular system to accomplish, how the system is performing against these goals, and the accessibility of points of leverage for change (see Meadows, 1999). As Simon (1996) has indicated, sometimes intervention entails redesigning processes, such as task management or time management. In other words, the *form*, or the designed outcome, is the *process*. That some human processes are intentionally designed — like communication, or service — is not a significant conceptual leap. So too do the flow charts that come out of the project management domains of development already evoke this thinking. We understand that to get from A to B, there will be steps in between, involving the delegation of tasks, dedication of resources, and evaluation of outcomes. This is not really what Alexander is driving at, neither is it the wicked part of design-based problem solving for sustainability.

Rather, the critical details in Alexander's (1964) described approach to decision making, in this instance, are the discernment designers exercise to determine when something is out of alignment in the form- to- context relationship, and the creative problem solving we undertake in effort to adjust the "fit" of one to the other. He (Alexander, 2002-2005) later expands a philosophy of design, which proposes that forms should emerge organically through a deep embeddedness within contexts, ideally diminishing our perception of a form-context boundary, or the separation between nature and culture. Implicit in this philosophy is the acceptance of human cultures (and the forms that we produce) as a natural part of the biosphere (or the contexts in which we are situated). Here, responsibility is placed on designers to engage authentically and comprehensively with the dynamics of a place, during development processes; we are expected to study the particular ecosystem and cultural heritage of the sites with which we are working (also see Lister 2010/2013). Shuffling our focus between form and context is arguably an essential ingredient in design for sustainability, at least in contemporary settings. In industrialised societies, it is clear that we have missed a step in determining the best fit between our forms and their contexts.

If the exclusive purview of design were to develop forms that met the specified needs of their contexts, then finding a successful fit between one and the other would mostly depend on effective information gathering and analyses. The design of forms would primarily take place in the service of context-based phenomena; the context, not the designers, would set design agendas. To a certain extent, this is what happens in conventional spatial, product, and graphic design projects: Clients outline the agendas. For example, a design brief for an

apartment development project might stipulate a fixed number of units, equipped with a desired collection of amenities, to house an anticipated number of tenants. If the building is developed to serve one or more demographic groups, such as elderly, immigrant, family, or young professional populations, the distinctive interests of these parties might be taken into consideration. However, the linear translation of an itemised 'wish list' into a design outcome would fail to capitalize on some of the best qualities of the design mindset: It is like the equivalent to the Kuhnian (1996/1992) 'puzzle solving' of 'normal science'. While we would not want every design initiative to be prompting a full throttle paradigm shift, we should also avoid side-lining problem framing from creative processes. In the example above, there is always room to reconsider how we organize housing services. As Alexander (1964), Rittel and Webber (1973), and Cross (2007) have alluded, jockeying between problem and solution frames, or forms and contexts, might enable designers to weave our way into some of the less accessible points of leverage for change within complex systems (see Meadows, 1999). This implies taking our assumptions about the state of a system with a grain of salt. Also, when we allow problem and solution frames to co-evolve we give ourselves the chance to adapt our role within the given contexts. For example, the explicit modification or construction of forms may not always be the most suitable approach to intervention, as is working with the many nested and overlapping relationships that exist between form and context: "This ability to deal with several layers of form-context boundaries in concert is an important part of what we often refer to as the designer's sense of organization" (Alexander, 1964, p. 18).

Thus, the targets for systems-oriented design for sustainability should be taken to be indefinite. Amidst designers' efforts to order systems, we inevitably engage in an organization of problem spaces. Consequently, the contexts within which we are working come under speculation as entities for prospective transformation. This is part of what Cross (2007) was referring to when he said that designers are misbehaved. While a classic design project may respond directly to a client brief, a systems-oriented designer might be inclined to turn this brief upside down and inside out. As much as we presume that contexts place demands on forms, it would not be unexpected for designers to invert the power in this relationship by investigating context-based or systems-level opportunities for change. Additionally, when the design solutions that are realized include things like social programming, the contexts may actually embody the forms; for example, service providers might carry forth a programme, local residents might experience its delivery, and feedback between the two might enable adjustment to the system as a whole. The forms are alive and mutable within their contexts, and the contexts continue to act on them. So, not only do problem and solution frames co-evolve during design decision making, but forms and contexts can also be exposed to reflexive interaction effects throughout the course of their existence together. The intricacy that Alexander (1964) underrepresents in his writing, as does Simon (1996), is that the context scenarios in complex adaptive systems would be prone to fluctuation, as a result of a variety of factors. For example, one that Brown (2010) has highlighted is the possible presence of competing worldviews. Thus, we cannot modify all contexts in the same way that we would redesign a street bench. If it is our ambition, as designers, to influence contexts along with forms, we could only do so responsibly with the understanding that we are shifting moving parts within a moving system. An emergent design practice would not shy away from this challenge, rather would use it to spark innovation. Systems integration could take place in layers, as co-evolutionary factors, such as stakeholder relationships or cultural development, mature and settle.

It is not that designers are unaccustomed to working within dynamic conditions. Clearly, many products, developments and services are intended for active engagement from users. Within the built environment, for example, it is normal for forms to be adapted in the course of their use. By nature, design thinking also embraces emergence, in that it is iterative and co-evolutionary, operates with a fuzzy view of final destinations, frequently adopts abductive

reasoning approaches and carries an inexpressible air of magic (Cross, 2007; Kolko, 2010, 2011). Still, contemporary design scenarios seem to be pressing the field to re-evaluate its relationship with change, especially with respect to sustainability transition. This qualitatively different kind of design could sit anywhere on the spectrum of accepting change, anticipating and planning for a plausible range of changes, creating conditions conducive to change, facilitating change or becoming immersed within broader change processes. We can see this approach, as a philosophy and practice, coalescing in the writing and projects of various systems-oriented designers. For example, it is apparent in Alexander's (2002–2005) discussion of the unfolding of "living structures", Van Alstyne and Logan's (2007) examination of design for emergence, Brown's (2012) outline of an evolutionary approach to design and Sevaldson's (2016) library of systemic relations. It is also evident in phased approaches to development; urban spaces that are customized by season; homes that adapt to the inevitability of users' aging; the schematic flexibility of modular design; the adaptive repurposing of materials, products and spaces; the rule-oriented methods of generative design; the self-organising processes of open-source design; and the social diversity of collaborative, multi-stakeholder design charrettes. This is only to suggest that some designers do, indeed, give consideration to their relationship with processes of change within complex systems, and that a qualitatively different kind of design, advanced in response to the wickedness of sustainability challenges, is already nascent.

The first small step for the development of emergent design methodologies is acknowledgement that complex systems are dynamic and not subject to absolute control. Determining how to play the role of 'co-creative agent' amidst messy systems, which cannot be packaged into clear project mandates, is the more considerable hurdle. In this regard, resilience and social innovation literature can offer insight. Both discourses characterise fundamental systems transformation as non-linear, syncopated, cross-scale and/or cyclical. For example, Geels and Schot's (2007) typology of sociotechnical transition pathways illustrates how major shifts often depend on the alignment and convergence of multiple factors across the niche, regime and landscape levels of a system. Holling's (2001) adaptive cycle traces (eco)system processes through four stages of change (exploitation, conservation, release and reorganisation), and signposts the windows for innovation that can surface throughout. Finally, with reference to the mutually reinforcing relationship between social innovation and resilience, Westley (2013) has encouraged us to nurture cultural conditions that are conducive to ongoing, combinatorial innovation, and to support leaders who can channel new alternatives through the networks of dominant systems. Designers can borrow from resilience and social innovation thinking this awareness of the processes and mechanisms that shape broader systems change, and acceptance that we are only one cluster of actors operating within them. Designing *for* and also *with* emergence might entail ongoing engagement with a system, wherein the designing is never quite finished and the outcomes continue to evolve in response to feedbacks (see Brown, 2012). The format of design processes might become more socially dispersive, and designers may turn attention towards influencing contexts just as often as we create forms.

Conclusion

As we designers embrace agendas for sustainability transition, we are also re-evaluating the nature of design practice. Sustainability challenges are mottled with wicked dilemmas, and any comprehensive approach to transition would necessarily address intersecting, complex adaptive phenomena. By exploring the diversity of designerly ways, we might identify means of refining designers' relationship with change, despite complexity. According to Brown:

> Like everything else in life, design is evolving, and in many ways we are being forced to give up the very essence of the Newtonian notion of design: the blueprint, which personifies control and defining every outcome of the design process.

(Brown 2012, p. 21).

This manuscript deconstructs designerly ways using the three lenses of adaptive response, creative agency and emergent engagement, presented as general approaches to design-like thought and action. Design as an adaptive response is described here as an immediate, direct, local, incremental and self-organised maintenance or shuffling of systems parts at a micro level; it implies a tacit and experiential way of coming to know the world in which we live. Design as creative agency is portrayed here as an intentional act of systems ordering; creative agents may also take on the interpretive role of analysing systemic order within the human-constructed domain. Design as emergent engagement is arguably decentralised, co-generative, cross-scale and phased, and takes place with a view to the macro-level dynamics of systems change; emergent design practice may include analyses of the relationships that arise between designed forms and design contexts, to identify the most appropriate alternatives for systems intervention.

In the first approach (adaptive response), we can gain expertise through our lived experiences, and may be intimately aware of ongoing systems fluctuations as a result of personal proximity to them; the drawback discussed by Berger (2009) is that the everyday design-like decisions of contemporary citizens may be reactive or unmindful of macro-level systems organisation. In the second approach (creative agency), we enjoy the confidence granted by our capacity to imagine, invent and innovate, although we may overestimate our abilities to effect positive systems change or attempt to do this too rapidly. The third approach (emergent engagement) calls for an overall refinement of the system of systems-oriented design. As systems designers, we are entering more extensively into the realm of the social (see Irwin, 2015), working with contexts (e.g. policies, services, and institutional structures) in addition to fashioning forms. Next, we might reassess how to contribute to processes of transformation at various systems scales and stages of change, through rigorous analyses of systems complexity and feedbacks, as well as engagement with multiple knowledge traditions (Brown, 2010; Simon, 1996). Finally, the first approach implies that everyone is a designer (Van der Ryn, 1996; Berger, 2009); the second is epitomised by outdated conceptions of isolated, aloof, rational creative visionaries (Mau et al., 2004; Simon, 1996; Tonkinwise, 2015); in the third, designers work in close collaboration with and on behalf of stakeholders and societies (Brown, 2010; Mau et al., 2004; Simon, 1996).

These are not discrete categories. We may find that these three designerly approaches are complementary, that they overlap within initiatives, and that one is more suitable for certain kinds of projects over another or appears most prominently at various points in history. For example, in an effort to fuse local with expert knowledge, provide democratic access to design processes and enable bottom-up change, open-source projects (see innonatives.com; openarchcollab.org) have become popular. In these, we see the faces of adaptive response, creative agency and emergent engagement intermingling. With open-source initiatives, we rely on acts of creative agency to develop the forums by which many people can adaptively self-organise; through these platforms collaborations by the masses progress, and through these collaborations, the platforms can subsequently be modified. In such cases, it may be tempting to assume that we have kicked contemporary designers out of the equation, altogether, to be replaced by adaptive citizen engagement. However, we should not overlook the fact that, in some instances, the development of these platforms would have entailed a long chain of cumulative invention and innovation, bringing us to the point where we can now work together in ways that appear organic. In this light, Brown (2009) has intimated that design expertise could never be entirely supplanted by self-organised, citizen action. He has questioned whether design by the masses is the most effective route to path-breaking innovation: "The idea of 'Everyman the Designer' is a compelling one, but the ability of consumers to generate

breakthrough ideas on their own—as opposed to replicating existing ideas more efficiently and cheaply—is far from proven" (Brown, 2009, p. 59). What he is saying is that, occasionally, adaptation is insufficient; sometimes we need to transform.[xi] Given the scope of sustainability challenges, macro-level analyses of complex systems dynamics are worth pursuing; at the same time, we could still use eyes and hands on the ground, with personalised, community-generated approaches to change.

Finally, in fairness to designers, even without the addition of a sustainability lens, design thinking and practice is already diverse. Within the past few decades, we have witnessed the fields of graphic, interior, industrial, engineering, architectural, urban and multimedia design become ever more multifaceted, integrated and systemic. This, too, has important implications for design for sustainability. Integrated practices enable holistic design inquiry and outcomes. Adding layers of socio-ecological analyses, or including other disciplinary experts in the conversation, is not a great leap from current norms. In addition, once a studio has adopted a sustainable design practice, it would be easy to slide into a design-for-sustainability mindset. Recognising the resonant global impact of small design choices can spawn curiosity regarding broader systems conditions. Accounting for the socio-ecological impacts of a particular design demonstrates conscientious practice; applying designerly ways to effect systems change for sustainability transition is an attempt at transformative practice.

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[i] *Ten properties of wicked problems:* (1) There is no definitive formulation of a wicked problem; (2) Wicked problems have no stopping rule; (3) Solutions to wicked problems are not true-or-false, but good-or-bad; (4) There is no immediate and no ultimate test of a solution to a wicked problem; (5) Every solution to a wicked problem is a 'one-shot operation'; because there is no opportunity to learn by trial-and-error, every attempt counts significantly; (6) Wicked problems do not have an enumerable (or an exhaustively describable) set of potential solutions, nor is there a well-described set of permissible operations that may be incorporated into the plan; (7) Every wicked problem is essentially unique; (8) Every wicked problem can be considered to be a symptom of another problem; (9) The existence of a discrepancy representing a wicked problem can be explained in numerous ways. The choice of explanation determines the nature of the problem's resolution; (10) The planner has no right to be wrong (excerpted from Rittel & Webber, 1973, p. 161-166).

[ii] *Complex adaptive systems*: "Complex adaptive systems (CASs) are distinguished not only by their diversity of components, nonlinear behaviors, complex (typically hierarchical) organization, multiscale nature, and homeostatic feedbacks; they are also unique in their ability to self-organize, or adapt, in response to environmental demands" (Cumming & Norberg, 2008, p. 246).

[iii] What I am describing as "design as an adaptive response" shares similarities with others' conceptions of "adaptive design", although it is positioned here as a generic human behaviour rather than a specific approach to design practice. Adaptive design is a term coined by Lister (2010/2013) "to refer to an integrated, whole-system, learning-based approach to the management of human-ecological interactions, with explicit implications for planning interventions and resulting design forms" (p. 539). Other colleagues have applied this concept with reference to design approaches that respond, over time, to the changing needs of users or conditions of sites. I have made note of these approaches in the third section, "Emergent Engagement".

[iv] *Adaptive capacity:* "The capacity of actors in a system to influence resilience" (Folke et al., 2010, p. 20).

[v] With reference to the creation of form, Alexander (1964) contrasted unselfconscious processes, which occur through imitation and correction, with selfconscious processes, which occur through the application of generalised, abstracted theories and principles.

[vi] *Adjacent possible:* "The adjacent possible is a kind of shadow future, hovering on the edges of the present state of things, a map of all the ways in which the present can reinvent itself" (Johnson, 2010, p.31).

[vii] *Design space:* The total set of prospective designs that could be rendered (Beinhocker, 2011).

[viii] "*Emergence* refers to the process by which a higher level of organisation arises through the aggregation and interaction of lower-level components, revealing new behaviours or properties not associated with the lower-level components" (Van Alstyne & Logan, 2007, p. 120–121).

[ix] As originally introduced by politician Donald Rumsfeld, as that which we know we don't know, compared with that which we don't know we don't know.

[x] As originally introduced by politician Donald Rumsfeld, as that which we know we don't know, compared with that which we don't know we don't know.

[xi] "*Transformability* refers to the capacity to transform the stability landscape itself to become a different kind of system, to create a fundamentally new system when ecological, economic or social structures make the existing system untenable" (Folke et al., 2010, p. 20).